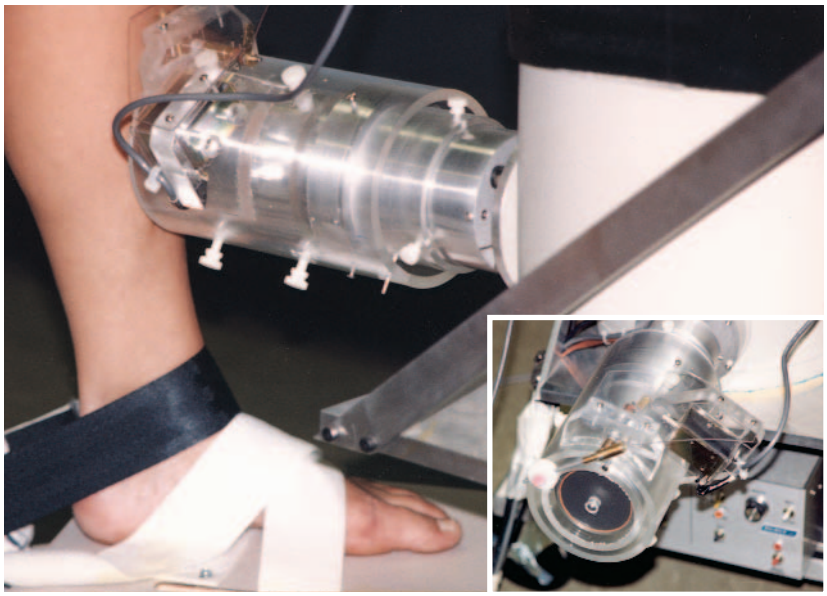
Measuring Lead Effects

Blood and Bone Together Are Better

Many studies have reported impaired renal function and kidney disease at high levels of lead exposure, as estimated mainly through concentrations of serum creatinine (SCr) and rates of creatinine clearance from the body. However, lower-level lead exposure has not been correlated with renal effects as conclusively, perhaps because blood lead reflects relatively recent exposure, and therefore is not an adequate measure of total body burden. This month, Shirng-Wern Tsaih of the Harvard School of Public Health and her colleagues report that blood lead levels alone may not be enough to determine whether kidney effects are occurring at low exposure; lead levels in bone also need to be determined [***EHP* 112:1178–1182**]. The Tsaih study is among the first to assess the relationship between low-level bone and blood lead levels and measures of kidney function in a general population sample.



A step in the right direction. Correlating bone lead measurements (obtained through K X-ray fluorescence) with blood lead data yields insights into adverse renal effects.

In contrast with blood lead, bone lead makes up more than 95% of the adult body burden. The lead in more compacted cortical bones, such as the tibia, is less available for mobilization, because this type of bone is less prone to turnover than spongier trabecular bones, such as the patella. Yet, as people age, bone loss often does take place, so lead that has long been held in bone is released to soft tissue and can find its way to the kidneys. Thus, bone lead may be a better marker for studying the chronic toxicity of accumulated exposure and lead burden.

The Tsaih study examined data from a cohort of middle-aged and elderly Boston men with no known heavy exposure to lead. Participants were from the Normative Aging Study, a federal study of aging begun in 1961. A blood sample for lead analysis had been collected every 3–5 years since July 1988; bone lead measurements began in August 1991, when a subset of participants were recruited for a substudy in which bone lead was measured by K X-ray fluorescence.

Tsaih and colleagues examined data for 448 men who had a baseline bone lead measurement between 1991 and 1995, and follow-up measurements of SCr 4–8 years later. They examined blood and bone lead concentrations and their correlation with kidney function, taking into account the known nephrotoxic effects of diabetes mellitus and hypertension, which had been diagnosed in 5.8% and 25.7% of the men, respectively, at the time of baseline measurement. Bone lead was measured in the tibia and patella.

Tibia lead was observed to be associated with increases in SCr levels in follow-up participants with diabetes. The findings suggest that long-term low-level lead accumulation, estimated by tibia lead, is associated with an increased risk of reduced renal function. This is especially true for diabetics and hypertensives, who already are at risk for kidney impairment because of their disease. In addition, blood lead and tibia lead appeared to be associated with elevated SCr levels and chronic kidney disease among hypertensives. There was no statistical evidence of patella lead being associated with change in renal function, suggesting that chronic absorption of lead is a risk factor for impaired renal function.

The study, however, has some limitations. Although SCr is widely used in medicine to measure overall renal function, it provides only a rough estimate of the kidney's filtration capacity. For instance, increases in SCr definitively show impairment only when kidney function has been reduced by about 50%. Thus, the researchers had great difficulty in detecting more modest effects of lead. In addition, the alternative hypothesis that elevated blood or bone lead levels actually result from impaired kidney function cannot be ruled out.

It has not yet been determined whether lead affects blood pressure indirectly through changes in kidney function, or via more direct effects on the circulatory system or neurological blood pressure control. The researchers also know of no studies to date that analyze the potential for diabetes to modify the relationship between lead exposure and renal function. Given that many adults have a history of environmental or occupational lead exposure and the incidence of both type 2 diabetes and hypertension, studies of such interactions, if confirmed, could be of significant public health value. **–Julian Josephson**

Risky Trade-offs

Bangladeshi Quest for Safe Water

In an attempt to eliminate epidemic levels of diarrhea and other infectious diseases associated with the use of surface waters, millions of shallow tube wells were drilled into the Ganges Delta alluvium in Bangladesh beginning in the early 1970s. This process reduced the rates of water-related infectious diseases but created a new public health dilemma: a surge in diseases such as skin ailments, diabetes mellitus, and various cancers, all resulting from habitual consumption of groundwater naturally high in arsenic.

A number of interventions have been proposed to help remedy the widespread arsenic exposure, but these interventions may only be bringing the catastrophic water situation in Bangladesh full circle. A new study by epidemiologists led by Kamalini Lokuge of the Australian National University suggests that, while these interventions will eventually result in less disease overall, they may initially cause a steady and considerable increase in diarrheal disease [***EHP* 112:1172–1177**]. The study indicates that any large-scale transition away from household tube wells as a source of drinking water, without proper evaluation of the risks, may be premature.

In attempting to quantify the disease burden resulting both from arsenic exposure and from the potential side effects of widely available arsenic mitigation interventions, Lokuge and her colleagues used previously published information to estimate mortality rates and disability-adjusted life years (DALYs). Simply put, a DALY is a measure of the burden of disease; it reflects how much a person's expectancy of healthy life is reduced by premature death as well as by disability caused by disease.

Carolyn Hoppin

The Australian team used World Health Organization data to estimate the DALYs lost per year to arsenic-related effects including diabetes, ischemic heart disease, and a number of cancers. They calculated that arsenic exposure causes the loss of 174,174 DALYs per year in Bangladeshis exposed to arsenic concentrations above 50 micrograms per liter (µg/L), the nation's cut-off point for safe drinking water.

Then they calculated the DALYs that would be lost to infectious disease, provided Bangladeshis adopted certain arsenic mitigation options currently advocated by the federal Bangladesh Arsenic Mitigation and Water Supply Project and immediately accessible to the majority of the Bangladeshi population year-round. These include surface water supplies, uncontaminated community tube wells, and low-cost filtration systems. These alternative options carry the potential for increased water-related infections, compared with household tube wells.

Assuming that mitigation efforts were undertaken only in those areas where the arsenic concentration of drinking water is highest (100–300 µg/L), the team found that the long-range benefits of arsenic mitigation in terms of DALYs gained and deaths avoided would outweigh any initial decline in public health due to water-related infectious diseases. However, there would initially be a period of some years (the number of which is still unknown) before any benefit would accrue, and some additional years until the total benefit outweighed the cost of the water-related infectious disease increase. The investigators also conclude, moreover, that if the Bangladeshi people gradually stop using the alternative water sources and processes (for example, because of the inconvenience of maintenance or complacency as disease drops off), the initial DALY-based cost of water-related infectious diseases would remain while the long-range benefits would disappear.

The study demonstrates that implementation of any arsenic-mitigating intervention must take into account not only the strategy's effectiveness in reducing arsenic exposure but also its safety in terms of water-related infectious diseases, the likelihood of population-wide compliance, and different exposure levels within the population. The investigators contend that such information is vital to developing appropriate policies toward resolving the drinking water crisis in Bangladesh. **–M. Nathaniel Mead**

Spraying on a Summer Night

A Safer Way to Stop West Nile Virus

A population-level study has shown that night-time pesticide spraying in the late summer and early fall, aimed at controlling adult mosquitoes that carry West Nile virus, can be done in a way that does not drive up the number of people seeking emergency care for asthma-related problems [***EHP* 112:1183–1187**]. A team led by Adam M. Karpati, a physician in the New York City Department of Health and Mental Hygiene, reports that in studies of the city's 2000 mosquito spraying season, no correlation could be found between broad application of sumithrin (a pyrethroid pesticide) and asthma cases presenting at the city's 11 public hospital emergency departments.

Earlier studies had shown that high exposure to pyrethroid pesticides—often in an occupational setting—can trigger reactions in asthma sufferers ranging from mild symptoms such as sneezing and scratchy throat to more acute ones such as wheezing, chest tightness, and even death. But no data have been available showing on a population scale how the lower-level exposures that come from public health spraying of pesticides affect the large number of asthmatics that may live in a big city.

The researchers tabulated data for asthma-related emergency room visits around the dates when a sumithrin-based pesticide was sprayed in each of 162 residential zip code areas in the city during July–September 2000. The timing of spraying within each zip code depended on whether surveillance indicated it was warranted—for example, if a dead bird were found to be infected with the virus, or if a human case were identified. A zip code area was rarely sprayed on consecutive days. The study also incorporated air quality data including daily measures of ozone, air particulates, and temperature, which can all cause fluctuations in the number of people seeking treatment for asthma-related symptoms. For a control, the team used asthma-related emergency room visits on days prior to spraying. They also looked at the number of asthma-related emergency room visits before and after the spraying season.

The researchers found that the number of asthma-related visits in the three days before application of the pesticide and the three days after were nearly identical. Looking more specifically within the emergency department data for asthma flare-ups in children and for aggravation of chronic obstructive pulmonary disease similarly yielded no correlation between spraying and symptoms.

The study does not necessarily show that public health pyrethroid spraying is not a danger to asthmatics. Rather, it could suggest that the city's method of application and/or the citizens' behavior during spraying helped minimize exposure. During 2000, the first year when New York City exclusively used a pyrethroid pesticide, the city limited its spraying to areas where the virus was detected in birds, mosquitoes, or humans, with spray trucks usually beginning their rounds near 10 p.m. and continuing through the night to 5 a.m. Radio, television, and print media were used to alert residents 48 hours prior to any spraying and to instruct people to remain indoors and close their windows during the hours when spraying would occur. **–Victoria McGovern**

Big Apple air okay. Mosquito pesticide spraying to prevent West Nile virus was not associated with an increase in asthma attacks.

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